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THE GENUS ARTOCARPUS IN THE HAWAIIAN ISLANDS

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The breadfruit is beyond question one of the most famous and valuable trees of the Pacific. For thousands of years it has been intimately associated with the peoples of Indo-Malaysia and Polynesia. On many of the tiny island groups in the South Pacific it has been a food-plant of supreme importance since time immemorial. In the Hawaiian Archipelago, whither it was brought by the early Polynesians, it was highly prized by the natives, and carefully cultivated. It has played an important rôle in the economy of all the peoples of the central Pacific.

There seems to be at present, in the literature, no comprehensive account of the breadfruit in the Pacific; the references are scattering and for the most part difficult of access; and it is the purpose of the present paper to give a salient account of this important tree and its congeners, particularly as they occur in the Hawaiian Archipelago. It is significant that nowhere in the literature is there a complete description of the tree and its parts; the extant characterizations, both botanical and non-technical, are noticeably fragmentary and unsatisfactory. The present paper undertakes a reasonably complete description of the tree and its relations to human welfare.

The genus *Artocarpus**—Greek for bread-fruit—is moraceous, and comprises about forty species, chiefly trees and shrubs, indigenous to the Indo-Malayan region. A number of the trees are locally valuable for timber; however, the two species

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* A. D. E. Elmer, Synopsis of Artocarpus, Leaflet Philipp. Botany, 2. 1909 see also Engler and Prantl.

of prime importance are the breadfruit and the jakfruit. The genus is characterized by copious latex; large, thick, alternate leaves, either entire or pinnate; and deciduous axillary stipules. The plants are monoecious, and the two kinds of flowers are on distinct receptacles. The staminate flowers occur in long, crowded spikes; each perigone has two to four lobes and a single exserted central stamen. The pistillate flowers are massed in more or less globular heads; the floret has a tubular, obovate, or linear perigone, and a simple, uniovulate ovary. The style protrudes through the narrow aperture of the perigone and bears a spathulate stigma, which is sometimes 2–3-fid. The ovule is anatropous. The fruit is a large syncarpium, formed of the fleshy receptacle and greatly enlarged, fleshy, aggregated perianths and carpels (anthocarps). The tips of the anthocarps are hardened, truncate, pyramidal or spinous. The seeds are without albumen; the embryo is straight or curved, with thick, fleshy, equal or unequal cotyledons. In general the genus is distinctive of tropical regions possessing a uniformly humid atmosphere, moist soil, and good drainage.

The breadfruit is by far the most important member of the genus, outranking in economic value and in geographic range all of the others combined. It is one of the world's great trees, and for beauty, unique features, and human interest, has a place beside the orange tree and the coco palm. In the botanic and semi-technical literature it is designated as *A. incisa* L.f., although its correct scientific name is *A. communis* Forst. The confusion in nomenclature has been carefully worked out by Baum,* who states:

"The genus *Artocarpus* was first described in 1776 by G. and G. J. R. Forster in 'Characteres Generum Plantarum,' a work written as a result of their botanical studies made during Captain Cook's second voyage into the Pacific and round the world between 1772 and 1775. The combination *Artocarpus communis* was given in this work for the breadfruit tree, a name which, according to nomenclatorial rules, must replace the generally accepted *Artocarpus incisa*, which was not published by the younger Linnaeus until 1781."

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* H. E. Baum, The Name of the Breadfruit, Science, N.S., **18**: 439. 1903, see also A. Richter, Botan. Centralbl., 60: 169–70. 1894.

The evidence is conclusively in favor of *A. communis*, although the other name will undoubtedly persist in the literature for a long time. Hillebrand, in his Flora of the Hawaiian Islands (1888), uses *A. incisa*.

There are many vernacular or native names for the breadfruit in common usage in the various countries where this tree is cultivated. At this point it is necessary to distinguish the two great groups or classes within the species, namely, the seed-producing or "wild" variety, and the seedless or cultivated variety. The seedless variety, or varieties (for there are many variations), is propagated solely by root cuttings or offshoots, and never occurs wild. All trees of this type are planted by human agency, although they may subsequently be abandoned and revert to a state of nature. These abandoned trees are not uncommon in the Hawaiian Islands, near the sites of former villages, and are often so closely associated with the true indigenous vegetation as to be easily mistaken for naturalized plants. The seed-producing variety, on the other hand, occurs spontaneously in many island groups, although it was not known in primitive Hawaii.

Attention will first be given to the seedless or cultivated form. This is known to the Hawaiians as *Ulu*, and it is significant that the same name is used by the Samoans, who are very closely related to the Hawaiians. In Tahiti the breadfruit is called *Uru* (the Polynesian *l* and *r* are interchangeable), and in Fiji, *Uto*. The names used in the Philippines are *Rima*, *Colo*, and *Kolo;* in Guam, *Lemae*, *Lemai*, *Lemay*, and *Rima*. The Spanish name, commonly used in the West Indies and Latin countries, is *Arbol del pan*. It may be pointed out that the name "breadfruit" is also applied to a rubiaceous shrub of northern Australia, *Gardenia edulis*, which bears a small, edible fruit. The "Hottentot Breadfruit" or "Kafir-Bread" of South Africa is the stem of *Encephalartos caffer*, which furnishes a starchy substance resembling sago. The "African Breadfruit" is a tree, *Treculia africana*, which has large round fruits containing numerous starchy seeds. The seeds are ground into meal and eaten by the natives.

The enumeration of the native names given to the seedless breadfruit indicates the geographic distribution of the species;* its home is the Indo-Malaysian region, like that of many other members of the genus, but it has been widely disseminated throughout the tropics. The Polynesian race took this valuable food-plant with them in their extensive migrations in the Pacific, and established it in all their island groups that possessed the climatic conditions requisite for its growth. New Zealand, the home of the Maoris, proved inhospitable to the breadfruit, and the natives failed to establish it there. The Hawaiian Archipelago, the northernmost boundary of Polynesia, was more favorable, but the tree never attained the importance in the dietary of the primitive Hawaiians which it held in the warmer islands to the south. It is noteworthy that whereas over twenty varieties were known by distinctive names to the inhabitants of Tahiti, Samoa, and Fiji, and twenty-five varieties were cultivated in the Caroline Islands, the Hawaiian had but a single variety. There are, of course, numerous variations in the Hawaiian breadfruit, but these are not comparable to the clearly defined varieties of southern Polynesia. Nor was the paucity due to any lack of horticultural ability on the part of the natives, for the Hawaiians were more skilful in their cultural processes than were their southern kinsfolk, and their other food-plants show large series of designated varieties.

The breadfruit in Hawaii is thus at the northern limit of its Oceanic range, and does not reach the stature or productiveness of the southern forms. The ecologic requirements for its maximum development apparently comprise the following: a warm, humid climate throughout the year, copious precipitation; moist fertile soil, and thorough drainage. The absence of any one of these conditions is a serious detriment to the normal growth of the plant, or may wholly prevent its fruiting. It is scarcely tolerant of shade, and in Hawaii large trees are almost invariably found growing in the open.

Mention may be made here of the famous adventures connected with the introduction of the breadfruit into the West Indies.

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* Fossil specimens are reported from California, Colorado, and Greenland.

Dampier and Cook both called attention to the tree as a source of food, and the latter recommended its transportation to the West Indian colonies. In 1787 Lieut. William Bligh was put in command of the *Bounty*, and commissioned to move a cargo of young trees from Tahiti to the West Indies. After the cargo had been secured and the vessel was on the return trip, a mutiny broke out, and Bligh and a portion of the crew were turned adrift in a small boat. The mutineers returned to Tahiti, from whence a number of them, with a few native men and women, sailed to Pitcairn Island, and established a remarkable colony there. Almost miraculously Bligh did not perish, but reached England, and was again commissioned to undertake the transplanting, which he successfully accomplished in 1792–93.

According to an ancient Hawaiian tradition the *Ulu* was introduced during that remote period of native history in which there was frequent intercourse with the homeland, "*Ka-hiki*," in the South Pacific. This was probably Samoa, rather than Tahiti. It is interesting to picture the remarkable canoe-voyages of the primitive Hawaiians back and forth across the vast stretches of the Pacific. As Lydgate states: "The successful introduction, perhaps acclimatization even, must have meant repeated voyages, extending over generations, or even centuries. And not time alone, but patience and skill must have been required for the successful introduction of a seedless tree like the breadfruit. Under favorable conditions it is not easy to propagate; exposed to the trying vicissitudes of a long canoe voyage; weeks of wind and weather and open sea; lack of water, burning sun and blighting spray, huddled into the bottom of the shallow canoe—how many, many failures there must have been!"

The voyagers, according to the legend, landed at Ewa, Oahu, and carried the precious young plants across the Ko'o-lau Mountains, to the Kualoa district. Here they were carefully planted and tended, probably under a heavy *tabu*. At the time of the coming of the first European explorers the breadfruit was plentiful around the native settlements and villages on all the islands; more plentiful than it has been at any subsequent period. It thrived in the humid regions of Kona and Hilo, on the island of Hawaii, and today there are many abandoned trees in these districts, marking the sites of once-populous Hawaiian villages. The extensive breadfruit groves of Lahaina, on Maui, were long famous for the excellence of their fruit. In humid valleys on Molokai, Oahu, and Kauai the tree was also abundant, rearing its splendid dome of glossy foliage high above the surrounding vegetation.

It is distinctly a tree of the valleys and lowlands in Hawaii, and with the decadence of the Hawaiian population, and the utilization of the fertile lowlands for sugar plantations, the majority of these fine old trees were sacrificed to make way for the white man's agriculture.

As has just been intimated, a mature *Ulu* tree possesses great beauty and dignity. As Melville states, "The bread-fruit tree, in its glorious prime, is a grand and towering object, forming the same feature in a Marquesan landscape that the patriarchal elm does in New England scenery. The latter tree it not a little resembles in height, in the wide spread of its stalwart branches, and in its venerable and imposing aspect." Although slow of growth, it eventually reaches a height of forty to sixty feet. The trunk is about two feet in diameter, but occasionally, on very old trees, measures three feet. It is normally quite straight and smooth, and rises to half its height, or at least ten or fifteen feet without a branch. The lower branches are the longest, and spread horizontally; the upper branches curve gently and gracefully at the ends. The branches are soft and brittle and are easily broken by the wind. Moreover, horses and cattle are very fond of the leaves and bark, so that trees are frequently disfigured through these agencies. These old, misshapen trees, that have been neglected for years, are not uncommon in Hawaii, and give the causal observer an entirely erroneous idea of the real character of the tree. When uninjured, the tree forms a magnificent high dome, casting a dense shade, and commanding attention because of its striking and distinctive beauty.

When growing in the soft moist soil which it prefers, the breadfruit roots shallowly and widely. Often a network of the exserted roots is visible above the ground. This habit is of the greatest value in propagation. The wounding or bruising of the root at any given point stimulates the production of an offshoot, and young plants for transplanting are produced solely in this way. This mode of propagation is naturally very slow and laborious, as the young shoots grow slowly, and are very sensitive to injury. A small breadfruit tree, rooted and ready for planting, commands a price of from one to five dollars in the Honolulu nurseries. The price varies with the size and thriftiness of the young trees.

Breadfruit roots are astringent and used medicinally by the natives as a purgative; they are sometimes macerated as a poultice and applied externally for various skin diseases.

The bark on the younger twigs is clear green; on the older branches it is smooth and gray. On the trunk it becomes half an inch or more thick, and in color very dark brown tinged with red; the surface is irregularly marked with obscure broken ridges. The inner bark is salmon-red, highly laticiferous and very fibrous; this material was formerly much used by the natives of the South Pacific for the manufacture of the coarser kinds of *tapa* or bark cloth. The making of *tapa* from the breadfruit bark does not appear to have been practiced in ancient Hawaii; perhaps because the *wauke*, *mamake*, and other plants were abundant, and the *Ulu* not so common. The *tapa ulu* was inferior to that of the *wauke* (paper mulberry) both in softness and whiteness, and was used by the common people, the finer sorts being reserved for the nobility. The bark was taken from the young trees, and the branches of old trees; the various stages in the preparation of the cloth were similar to those employed in the manufacture of *tapa wauke*.

The breadfruit wood is a fine, bright yellow, turning darker upon exposure to the air, and finally becoming dark brown. The sapwood is light cream color. The wood is rather light in weight and soft in texture; the grain is open and coarse. It is strong, elastic, and resistant to the attacks of termites; if kept dry it is quite durable; its specific gravity is 0.495. In ancient Hawaii it was used for a variety of purposes by the natives, such as house timbers, in the construction of the temples, etc. It was occasionally used for canoe bodies, but was not especially satisfactory for that purpose. In general the tree was much too valuable as a fruit-tree to be utilized for timber, and breadfruit wood is used chiefly in those regions that have an abundance of the wild, seed-producing variety. According to Safford, "In Samoa the framework of the roofs of all the best houses is made of the curved limbs of the breadfruit, beautifully rounded and scarped together and wrapped at the joints with cocoanut sennit." Several other species of *Artocarpus*, notably *A. hirsuta* and *A. chapalasha* of India, yield valuable mahogany-like cabinet woods, but these species do not occur in the Hawaiian Islands.

The breadfruit tree is highly laticiferous.* The milk is used by the Hawaiians, and by the natives of other regions, for glue, calking, and bird-lime. In Samoa it is chewed by the children, like gum. Safford states that

"Besides using the latex in calking boats, the natives of Guam find it, when fresh and viscid, an excellent medium for mixing paint, and it is a good sizing for whitewash. The usual pigments were a red ferruginous earth and lampblack made by burning cocoanut shells. The Caroline Islanders still use it with various pigments for painting their canoes, and it resists the action of water pretty well, though for this purpose it is inferior to oil."†

According to Baum‡ "The breadfruit trees throughout Porto Rico are scarred with machete marks made by the natives for the purpose of obtaining milk which they boil with coconut oil to obtain the thick, gummy substance used in caulking canoes and rendering bottles watertight." The breadfruit latex will probably never assume commercial importance, nor compete with the rubbers now on the markets, unless the methods of extraction and treatment for its gums are greatly improved.§

The leaf-buds and the floral buds of the breadfruit are large and showy, the latter more so than the former. The young leaves are conduplicate. The mature leaves are one to three feet long, with thick, short petioles. On young plants and shoots the leaves are frequently very much larger than normal; dwarf leaves are common on the fruiting branches. The shape is variable, on different trees and on different parts of the same tree. In general it is ovate or oblong, cuneate and entire at the base, with the upper part three to nine pinnately lobed. The lobes are acute or somewhat obtuse; the margin is smooth. The texture of the leaf is coriaceous, the old leaves becoming very leathery; the surface is glossy, scabrous, with minute, scattering, appressed hairs. The color above is a rich, dark green, very dark and heavy in the old foliage; the under surface is pale green. The venation is strong and conspicuous. The petioles, green parts of the branches, and peduncles are covered with very short, fine, harsh hair. The two stipules are very large, showy, axillary, free, and furled about the bud, but soon deciduous. They leave conspicuous amplexicaul annular scars on the twigs.

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* See G. Fendler and H. Thoms, Bericht uber die Untersuchung der Milksafte von Artocarpus incisa, Notizbl. bot. Garten, Berlin, Vol. 4, pp. 285–86, 1907; also G. Fendler, same title, Arb. pharm. Inst., Vol. 5, pp. 280–81, 1908.

† W. E. Safford, Useful Plants of Guam, U. S. Nat. Herb., Vol. 9, 1905, p. 190.

‡ H. E. Baum, The Breadfruit, The Plant World, Vol. 6, pp. 197, 225, and 273.

§ Biffin, in Kew Bulletin, 140: 177–181. Aug., 1898.

No special uses are known for the leaves of the Hawaiian *Ulu* but Melville gives an interesting account of the Marquesan form:

"The leaves of the bread-fruit are of great size, and their edges are cut and scalloped as fantastically as those of a lady's lace collar. As they annually tend toward decay, they almost rival, in the brilliant variety of their gradually changing hues, the fleeting shades of the expiring dolphin. The autumnal tints of our American forests, glorious as they are, sink into nothing in comparison with this tree.

"The leaf, in one particular stage, when nearly all the prismatic colors are blended on its surface, is often converted by the natives into a superb and striking head-dress. The principal fibre traversing its length being split open a convenient distance and the elastic sides of the aperture pressed apart, the head is inserted between them, the leaf drooping on one side, with its forward half turned jauntily up on the brows, and the remaining part spreading laterally behind the ears."*

The breadfruit leaves in Hawaii do not assume the gorgeous coloring described by Melville, but they do change to beautiful yellows and russets. Melville's account is probably somewhat exuberant. The petiole scars are round, symmetrical, and showy, with easily-seen bundle scars. A breadfruit branch, back of the foliage-bearing portion, is attractively marked with the petiole- and stipule-scars, and lenticels.

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* Herman Melville, Typee, 1846.

In the Hawaiian Islands the flowering and fruiting season of the breadfruit is very short as compared with that of more tropical countries. It extends from May or June through the summer into August,—a scant three or four months. There is some variation, of course, at different elevations and on the different islands. In the tropical and South Pacific, however, the season is eight to ten months in duration; in Guam it is about nine months. In a few very favorable Indo-Malaysian regions the tree produces two or three crops annually.

The flowers are terminal or nearly so, on the young wood, as contrasting with the Jakfruit tree, which fruits from the trunk and old wood. The staminate flowers are compacted in dense, club-shaped catkins, ten to sixteen inches long. At first both the staminate and pistillate clusters are covered by two large, showy spathaceous bracts, which are soon caducous. The perigon of the staminate flowers is two-lobed. The male catkin was called *Po-ulu* by the Hawaiians, who formerly mixed it with the fiber of the *wauke* in the manufacture of a certain rare kind of tapa called *tapa po-ulu.* No information is available to indicate why the catkins were thus used.

The female flowers are clustered in subglobular or globular echinate heads, with a spongy receptacle; the perigones are tubular or obovate; pistil with a two or three branched stigma. In the seedless variety no fertilization takes place. The fruit slowly enlarges to a diameter of six to eighteen inches and a weight of one to ten pounds. It is attached by a short, thick stalk, and grows either singly, or in clusters of two or three close together. It is oval or spheroid; bright green at first, becoming brownish when partially ripe, and rich yellow when thoroughly ripe. In the seed-producing typical form the rind is covered with short, hard projections (muricate), but in the seedless cultivated forms it is quite smooth and merely reticulate. The rind is relatively thin and fragile; the fruit bruises easily, and does not stand shipping.

The pulp or flesh is pure white at first, becoming creamy yellow upon maturity. The young fruit contains abundant latex; the old fruits are characterized by a strong and distinctive odor. The fibrous material extends radially from the receptacle to the rind, and is negligible in the better varieties; the total amount of fiber is only four per cent. The fruit contains more starch (25 per cent) and less water (25–30 per cent) than either the yam or the sweet potato.*

The breadfruit is never eaten raw, as it is unfit for human consumption until thoroughly cooked. In parts of the Hawaiian Islands where the swine are able to forage under the trees, they greedily devour the windfalls, and become very fat.

Excellent accounts of the preparation of the breadfruit are contained in the narratives of the various Pacific explorers, and are reproduced herewith:

"It is eaten before it becomes ripe, while the pulp is still white and mealy, of a consistency between new bread and sweet potatoes. In Guam it was formerly cooked after the manner of most Pacific aborigines, by means of heated stones in a hole in the earth, layers of the stones, breadfruit, and green leaves alternating It is still sometimes cooked in this way on ranches; but the usual way of cooking it is to boil it or to bake it in ovens; or it is cut in slices and fried like potatoes. The last method is the one usually preferred by foreigners. The fruit baked or boiled is rather tasteless by itself, but with salt and butter or with gravy it is a palatable as well as a nutritious article of diet. Ovens were introduced into Guam by the Mexican soldiers who were brought by the Spaniards. . . . They are of masonry and of the typical dome shape of the ovens so common in Mexico. A kind of biscuit is made by slicing the fruit into moderately thin sections after having cooked it, and drying the slices either in the sun or in ovens. Thus prepared it will last from one breadfruit season to another. The dried slices may be eaten either as they are or toasted, or ground up and cooked in various ways. The Caroline Islanders . . . follow a custom widely spread in the Pacific of preserving breadfruit in pits, where it ferments and is converted into a mass resembling new cheese, in which state it gives forth a very disgreeable odor. The fermented paste is made into cakes and baked, and is then palatable and nutritious. This method of preserving breadfruit is also followed by the Samoans, who call the cakes '*masi*,' a name now applied by them to ship biscuit and crackers. In Rarotonga the fermented paste is called '*mai*.'*

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* Hawaiian Planters' Monthly, 13: 315. July 1894.

Herman Melville gives a lively account in his romantic story of "Typee":

"The most simple manner (of cooking) consists in placing any number of the freshly-plucked fruit, when in a particular state of greenness, among the embers of a fire, in the same way that you would roast a potato. After the lapse of ten or fifteen minutes, the green rind embrowns and cracks, showing through the fissures in its sides the milk-white interior. As soon as it cools the rind drops off, and you then have the soft round pulp in its purest and most delicious state. Thus eaten, it has a mild and pleasing favor.

"Sometimes after having been roasted in the fire, the natives snatch it briskly from the embers, and permitting it to slip out of the yielding rind into a vessel of cold water, stir up the mixture, which they call 'bo-a-so.' I never could endure this compound. . . .

"There is one form, however, in which the fruit is occasionally served, that renders it a dish fit for a king. As soon as it is taken from the fire the exterior is removed, the core extracted, and the remaining part is placed in a sort of shallow stone mortar, and briskly worked with a pestle of the same substance. While one person is performing this operation, another takes a ripe cocoanut, and breaking it in half, which they also do very cleverly, proceeds to grate the juicy meat into fine particles. . . . Having obtained a quantity sufficient for his purpose, he places it in a bag made of the net-like fibrous substance attached to all cocoanut trees, and compressing it over the bread-fruit, which being now sufficiently pounded, is put into a wooden bowl—extracts a thick creamy milk. The delicious liquid soon bubbles around the fruit, and leaves it at last just peeping above its surface. This preparation is called 'kokoo' and a most luscious preparation it is.

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* W. E. Safford, Useful Plants of Guam, Contr. U. S. Nat. Herb., 9: 189. 1905. See also Seeman, Flora Vitiensis.

". . . the great staple articles of food into which the bread-fruit is converted by these natives are known respectively by the names of Amar and Poee-poee.

"At a certain season of the year, when the fruit of the hundred groves of the valley has reached its maturity, and hangs in golden spheres from every branch, the islanders assemble in harvest groups, and garner in the abundance which surrounds them. The trees are stripped of their nodding burdens, which, easily freed from the rind and core, are gathered together in capacious wooden vessels, where the pulpy fruit is soon worked by a stone pestle, vigorously applied, into a blended mass of doughy consistency, called by the natives 'Tutao.' This is then divided into separate parcels, which, after being made up into stout packages, enveloped in successive folds of leaves, and bound round with thongs of bark, are stored away in large receptacles hollowed in the earth, from whence they are drawn as occasion requires.

"In this condition the Tutao sometimes remains for years, and even is thought to improve by age. Before it is fit to be eaten, however, it has to undergo an additional process. A primitive oven is scooped in the ground, and its bottom being loosely covered with stones, a large fire is kindled within it. As soon as the requisite degree of heat is attained the embers are removed, and the surface of the stones being covered with thick layers of leaves, one of the large packages of Tutao is deposited upon them, and overspread with another layer of leaves. The whole is then quickly heaped up with earth, and forms a sloping mound.

"The Tutao thus baked is called 'Amar'; the action of the oven having converted it into an amber-coloured caky substance, a little tart, but not at all disagreeable to the taste.

"By another and final process the 'Amar' is changed into 'Poee-poee.' This transition is rapidly effected. The amar is placed in a vessel and mixed with water until it gains a proper pudding-like consistency, when, without further preparation, it is ready for use. This is the form in which the 'Tutao' is generally consumed."

Captain Cook gave an interesting account of the fermenting of the breadfruit by the Tahitians:*

"The fruit is gathered just before it is perfectly ripe, and being laid in heaps, is closely covered with leaves; in this state it undergoes a fermentation, and becomes disagreeably sweet; the core is then taken out entire, which is done by gently pulling the stalk, and the rest of the fruit is thrown into a hole which is dug for the purpose, generally in the houses, and neatly covered in the bottom and sides with grass; the whole is then covered with leaves, and heavy stones laid upon them; in this stage it undergoes a second fermentation, and becomes sour, after which it will suffer no change for many months; it is taken out of the hole as it is wanted for use, and being made into balls, it is wrapped up in leaves, and baked; after it is dressed it will keep five or six weeks. It is eaten both hot and cold, and the natives seldom make a meal without it. . . ."

Crozet's narrative contains an interesting record of the early uses of the breadfruit in the island of Guam:

"The fruit can be eaten when it has attained its full size, but though it still be green. In this stage the islanders cook it before eating; they take off its knotty rind and cut it in slices like pieces of bread. When they wish to preserve it, they cut it in round slices, and in this very thin sea-biscuit form they dry it in the sun or in the oven. This natural biscuit preserves its quality for years, and very much better than does our ships' biscuit. Our sailors ate it green, slightly grilled; they also made their soup of it; they had no other bread, and we attributed the quick recovery of those suffering from scurvy to the breadfruit diet. To this diet the inhabitants have always attributed antiscorbutic properties.

"When this fruit is ripe, it becomes yellow and soft, its odour is more fragrant, but it loses its farinaceous taste and becomes insipid. At this stage it has no longer the same properties as before; it is now laxative and heating; its pulp no longer takes the place of bread, and it has little to recommend it. Some of the breadfruit trees bear the male fruit and others bear female fruit. In the latter, which are rare, the seed consists of shell-less stones enveloped in a simple almost cylindrical pellicle of about the size of a chestnut but longer. When ripe these stones make up for the uselessness of the pulp; they are cooked and eaten like chestnuts, having the same taste.

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* Cook's First Voyage, Hawkesworth ed., Vol. 2, pp. 211–13.

"As the male breadfruit tree is the most useful, but has no seed, it is propagated by the Indians by making slight incisions in the root, from which shoots spring up; these are transplanted together with a piece of the original root which has produced them."*

Alfred Russel Wallace, in the Malay Archipelago† writes:

"We sometimes made curry or stew of it, or fried it in slices; but it is no way so good as simply baked. It may be eaten sweet or savory. With meat and gravy it is a vegetable superior to any I know, either in temperate or tropical countries. With sugar, milk, butter, or treacle, it is a delicious pudding, having a very slight and delicate but characteristic flavour, which, like that of good bread and potatoes, one never gets tired of."

In addition to the Hawaiian *Ulu*, which is the most common breadfruit in the Hawaiian Islands, there are at least three other varieties of *communis* represented to a lesser degree. The Samoan breadfruit was introduced into Hawaii by Mr. James Bicknell. The leaf is not lobed as deeply as that of the Hawaiian variety. The fruit is globular, with a distinctive raised collar or annular protuberance surrounding the place of attachment to the peduncle, which is unusually long. The flesh is orange yellow in color, and very sweet. The Tahitian breadfruit is another introduced form, but is comparatively rare. It is to be found in some of the old Honolulu gardens. The leaves are nearly entire, with very few incisions. The fruit is oblong, with deep yellow flesh.

The seed-producing or typical breadfruit was introduced into the Hawaiian Islands from the Caroline group. It has a variety of vernacular names—*Ulu-ma'a* in Samoa; *Uto-sore* in Fiji; *Dugdug* or *dogdog* in Guam; *Tipolo* or *Antipolo* in the Philippines; *Bulia* in the Solomon Islands; Breadnut in Burma; and *Castāna* in the West Indies. Although rare in the Hawaiian group, it "grows everywhere in Guam—in the woods, on rocky cliffs, and in low, sandy soil. It is the chief source of timber and of gum, the seedless *lemae* being too valuable as a fruit tree to be used generally for these articles. The fruit of the *dugdug* is inferior to that of the *lemae*, than which it is softer and more sweetish. It is seldom eaten, but its seeds, called '*nangka*' . . . are rich in oil and are relished by the natives. They are eaten roasted or boiled and are much like chestnuts." This use of the seeds by the natives is not confined to Guam, but occurs in all countries where the seeded form grows.

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* Crozet's Voyage to Tasmania, New Zealand, etc., in 1771–1772, trans. by H. Ling Roth, London, 1891, p. 88. This refers to the breadfruit as raised in Guam. The seedless variety is erroneously called the male tree.

† 10th ed., 1894, p. 233.

The second species of *Artocarpus* found in the Hawaiian Islands is the Jakfruit or Jackfruit, *A. integrifolia* L. It is native to Indo-Malaysia, and was introduced by Mr. David Forbes, of Kukuihaele, Hawaii. It is a large handsome tree rising twenty-five to eighty feet. The leaves are four to six inches long, and quite variable in shape; entire or sometimes three-lobed, obovate or oblong, very shortly acuminate, base acute; glossy; stipules spathaceous, deciduous. The flowers resemble those of the breadfruit, except that the female flowers are borne on the old wood and trunk. The fruit is very large, twelve to thirty inches long and six to twelve inches in diameter; the weight varied from twenty to sixty pounds. The rind is green and conspicuously muricate. The flesh is strongly odorous, and when fully ripe is literally overpowering. It is decidedly inferior to the breadfruit. The wood of the Jakfruit is yellow when first cut, but soon darkens to a rich mahogany color. It is used in Asia and Europe for musical instruments, marquetry work, brush backs, and for other fancy and ornamental purposes. The Jakfruit is not common enough in Hawaii to be of any commercial importance.

The most important factor in the development of the breadfruit as a commerical possibility in the Hawaiian Islands is the oceanic transportation. The fruit is a poor shipper, and until a fairly good market and better shipping facilities are assured, the breadfruit will be confined to strictly tropical markets.

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PINUS CARIBAEA: AN EXTENSION OF RANGE IN LOUISIANA

By Wilbur R. Mattoon

Louisiana, west of the Pearl River watershed, has never been included within the range of *Pinus caribaea* Morelet, by any authority so far as has come to the attention of the writer. The western range of the species, as given by Sargent, is "along the Gulf coast to the valley of the Pear River, Louisiana."*

During a southern trip in the spring of 1916, the writer had occasion to observe closely *Pinus caribaea* from its northeastern limit near Charleston, S. C., westward across the coastal plain into Mississippi and Louisiana. At Slidell, St. Tammany Parish, west of the Pearl River basin in Louisiana, reproduction from scattering seed trees left in logging occurs over the flatland and about vacant lots and yards in town. The resulting local landscape effect is most pleasing and leaves no doubt as to the opinion that slash pine is "by far the most handsome of all southern pines."† The numerous outlying ponds contain cull trees about their margins and heavy stands of young slash within and generally for some distance around the ponds. The soil here is the low flatland type consisting of sand overlying clay. A striking advance of slash pine over ponds and flat swamps, formerly occupied by cypress and some of the so-called hardwoods, has taken place extensively in the south due to the removal by logging of the former continuous and protective virgin forest cover. North of Slidell, pure stands of mature slash pine cover mile after mile along the New Orleans Great Northern Railroad

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* Sargent, Chas. S., Manual of the Trees of North America, page 18.

† Sargent, C. S., quoted by George Engelmann in the Revision of the Genus *Pinus* and Description of *Pinus Elliotii*, Transactions of the St. Louis Academy of Science, Vol. IV.